

# A Study on the Influence Mechanism of Community Loose Spaces on Child-Guardian Behavioral Characteristics From a Spatio-Temporal Perspective

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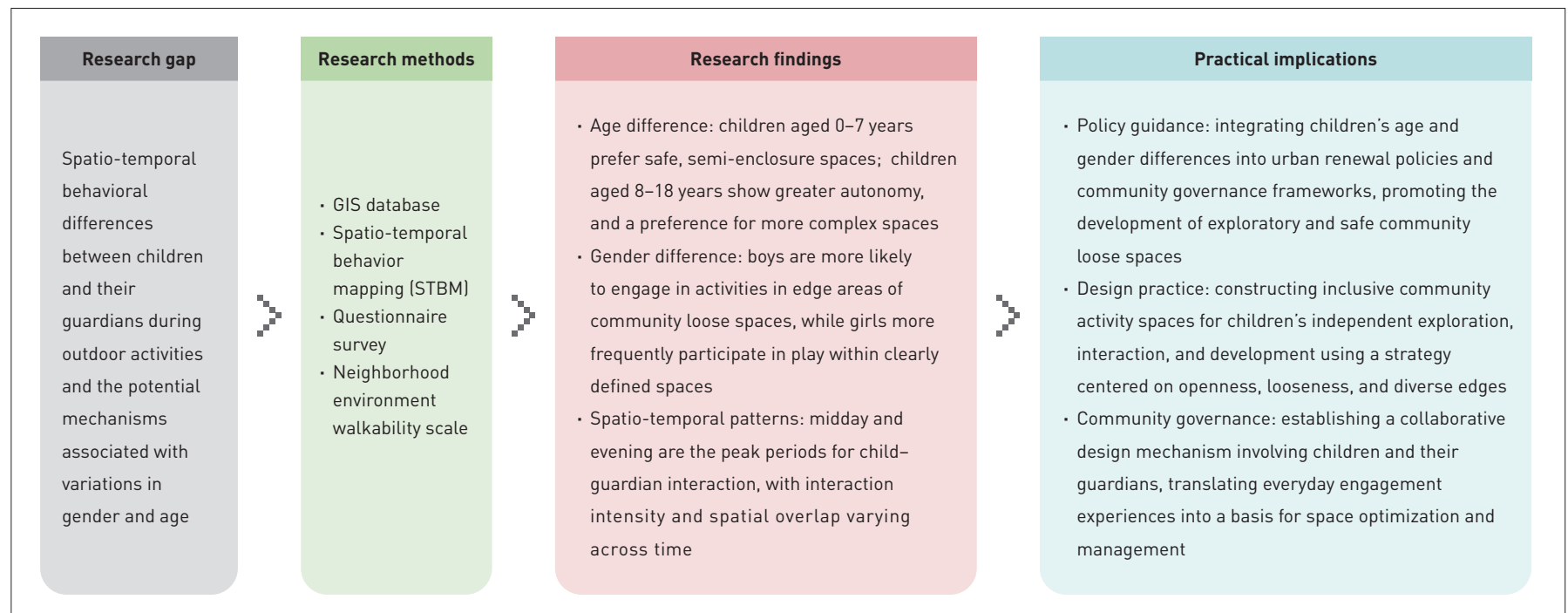
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## GRAPHICAL ABSTRACT



## ABSTRACT

As an important carrier for children's everyday activity engagement, the optimization of landscape elements in community public space has a positive influence on promoting children's health. However, existing studies have paid limited attention to spatio-temporal behavioral differences between children and their guardians during outdoor activities, as well as to the potential mechanisms associated with variations in gender and age. The current study takes FCC Central City Community in Fangshan

District, Beijing, as the research site. By integrating spatio-temporal behavior mapping ( $N = 988$ ) with the Neighborhood Environment Walkability Scale ( $N = 302$ ), this study examines spatio-temporal behavioral patterns of children and their guardians across gender, age, activity types, and time periods. The following results were revealed. 1) The number of activities involving boys is roughly equivalent to that of girls; however, during the evening hours, the number of boys is significantly higher than that of girls; during this

period, boys tend to engage in activities in edge area of the site, whereas girls are more likely to gather around play facilities. 2) Male guardians greatly participate in children's activities during weekends or evenings; while female guardians' involvement spans across various time periods of children's daily routines. 3) Gender differences are closely related to gender roles shaped by social culture. Specifically, the gender of guardians determines the frequency and duration of their time with children, and also shapes children's activity types and spatial preferences. Furthermore, this study reveals that transportation modes and travel motivations also influence children's participation in outdoor activities. Through empirical research, therefore, this study aims to provide a theoretical and practical foundation for the design of child-friendly communities, fully considering the spatial characteristic needs of different genders and age groups, thereby enhancing the quality of children's outdoor activities and guardian's everyday engagement.

## KEYWORDS

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Everyday Activity Space; Child-friendly Community; Spatio-temporal Behavior Mapping; Gender Difference; Environment-Behavior Characteristic; Spatial Perception

## HIGHLIGHTS

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- Boys' activity ranges tend to explore an "edge-facility" spatial configuration
- Child-guardian interactions are bidirectional, jointly shaping behavior and spatial choice
- Gender and age differences should inform more effective child-friendly community design

## RESEARCH FUND

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## 1 Research Background

Children are the future of cities and constitute a fundamental basis for sustainable social development. The Child Friendly Cities Initiative (CFCI) proposed by UNICEF in 1996, together with the subsequent Convention on the Rights of the Child, both focus on the necessity to use policy-driven and design-based strategies to

protect the rights of children to participation and health in cities<sup>[1-2]</sup>. According to the United Nations' statistics in 2020, there were approximately 298 million children in China, which was 21.1% of the overall population; of these, about 187 million lived in the urban regions, making up almost two-thirds (62.9%) of the total child population in the country<sup>[3]</sup>. However, over the past three decades, rapid urbanization in China has progressively compressed the spaces available for children's activities. Outdoor activity levels among school-aged children have declined markedly, contributing to a sustained increase in childhood obesity rates<sup>[4-5]</sup>.

The CFCI has, in fact, been implemented in more than 400 cities around the world<sup>[6]</sup>. Meanwhile, a growing amount of research attention has gradually shifted to children's behavioral patterns in cities, their personal perceptions of the built environment, and the complex interactions between behaviors and environment<sup>[7]</sup>. Existing evidence indicates that multiple underlying factors influence children's outdoor activity participation. Among the most salient are age- and gender-related differences, various modes of guardian participation, and distinct patterns of time allocation<sup>[8-13]</sup>. Guardians play an essential role in children's outdoor activities, as they not only are caregivers of children's safety, but also shape their behavioral patterns<sup>[14]</sup>. A growing body of research has highlighted that everyday parent-child interactions have gradually become an important and widely discussed topic in child behavior studies and environmental psychology<sup>[15]</sup>. Moreover, as the trend of population aging continues, the proportion of older adults who serve as caregivers is also steadily increasing<sup>[16-17]</sup>. In addition, children's daily outdoor activity duration and frequency exhibit strong temporal dependence. There are relatively consistent differences between weekdays and weekends, across different seasons and holidays, and in relation to guardian's time allocation<sup>[14,18]</sup>. Clarifying the complex interplay among these factors is thus essential for refining child-friendly community environmental design and for systematically improving the overall quality of children's outdoor activities.

Compared with more formal types of spaces, such as parks, plazas, and specially designed children playground facilities<sup>[19]</sup>, the so-called "loose spaces"<sup>[20]</sup>, which are part of daily life, including streets and alleys, the space around shops, and open activity areas, tend to be more successful in attracting children's active participation and sustained use<sup>[21-23]</sup>. Nevertheless, comprehensive research on the actual behaviors of children and their guardians and how their social and spatial relations operate in these open spaces remains limited, especially in terms of understanding the interaction mechanisms that work where age, gender, and temporal

dimensions intersect<sup>[7,14,18,22-23]</sup>. In response to this gap, this research will pay close attention to child-guardian outdoor activities patterns in community loose spaces and examine how spatial distribution of such participation varies across different temporal contexts. Specifically, this study seeks to address the following research questions:

1) Do children's age and gender differ in outdoor activity participation (e.g., the choice of activity spaces)?

2) Across different time periods, is children's outdoor activity participation (e.g., activity range, spatial clustering) influenced by caregivers?

3) Does guardians' gender affect childcare time allocation and spatial use preferences?

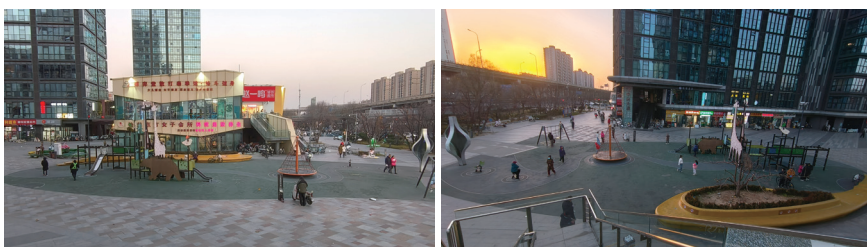
By examining the spatio-temporal behavioral characteristics of children's and their guardians' everyday activities, this study provides new empirical evidence to inform the design of child-friendly communities, which contributes more practical strategies for promoting children's participation in outdoor activities.

## 2 Research Content

### 2.1 Study Area

The study was conducted in the FCC Central City Community, located in Fangshan District of Beijing. Owing to its distinct location and socio-economic characteristics, the community is a typical peri-urban neighborhood within a megacity. It accommodates a large cross-district commuting population and exhibits a pronounced temporal pattern characterized by high dynamic density during morning and evening peak hours, contrasted with relatively low levels of daytime occupancy<sup>[24]</sup>. Based on these characteristics, the site south of Building 2 was selected as the study area (Fig. 1). It covers approximate 772 m<sup>2</sup> and was built gradually between 2017 and 2019. The site has numerous recreational amenities that appeal to children and their guardians, providing a foundation for analyzing outdoor activity patterns in loose spaces within communities.

Fig. 1 On-site photos of the study area.



## 2.2 Research Methods

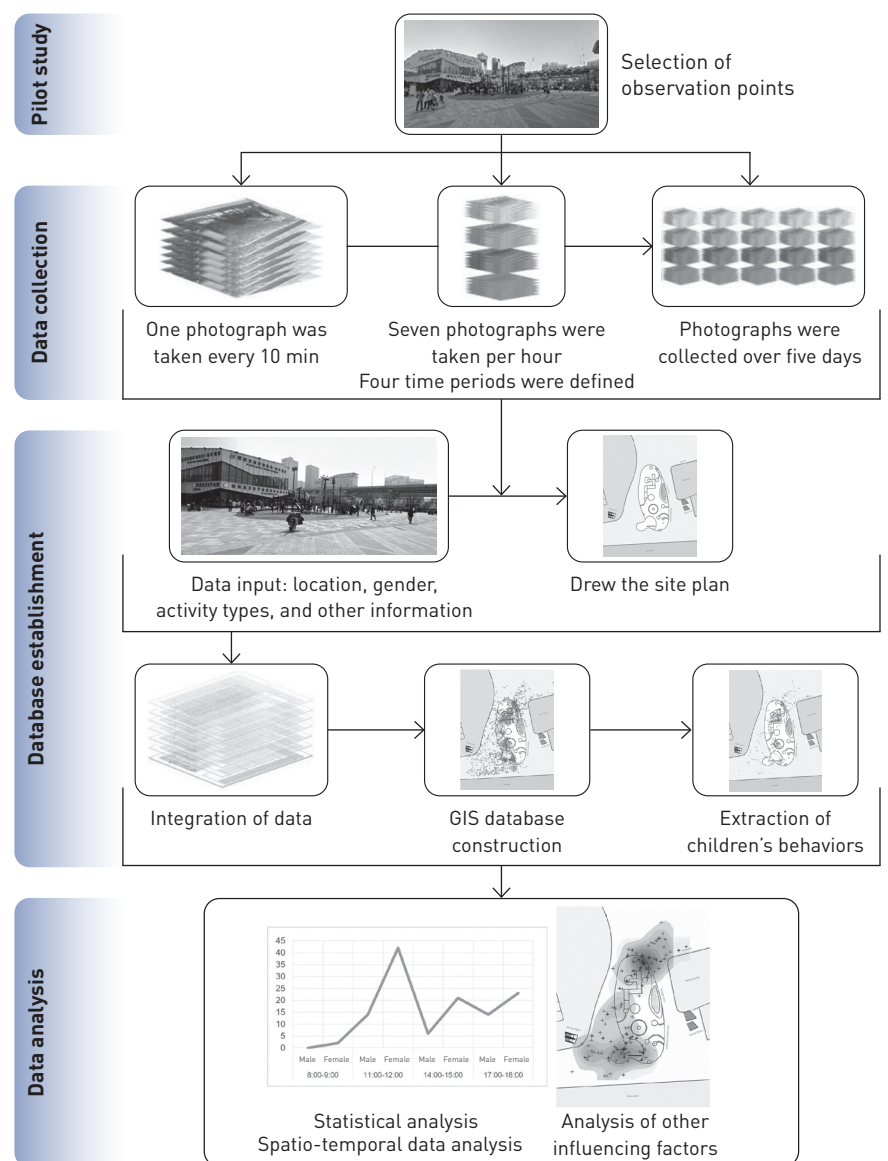
### 2.2.1 On-site Observation and Spatio-Temporal Behavior Mapping

This study employed on-site observation in combination with spatio-temporal behavior mapping (STBM)<sup>[25-26]</sup> to examine the spatio-temporal behavioral characteristics of children and their guardians. Specifically, STBM method systematically records key attributes of observed participants, including gender, age, activity type, and time period, covering both weekdays and weekends, through continuous observation and structured data collection procedures<sup>[27-28]</sup>. The research process comprised four stages (Fig. 2).

1) Pilot study: assess the feasibility of the observation tools and recording protocol.

2) Data collection: involve systematic observation and recording of children's and guardians' behaviors.

Fig. 2 Flowchart of the STBM research method.



3) GIS database establishment: geocode (spatialize) and integrate the observed behavioral data.

4) Data analysis: use ArcGIS to characterize spatio-temporal distributions and to examine correlational relationships among behavioral variables.

First, during the pilot study stage, a site survey was conducted and a detailed plan drawing was produced. Researchers also assessed the surrounding conditions, delineated the boundaries of the study area, and identified specific observation points (Fig. 3).

Second, at the data collection stage, systematic observations were carried out on March 9, 11, 15, 17, and 19, 2023, including three weekdays and two weekend days to capture variations in use patterns. Observations were conducted four times a day—morning (08:00–09:00), noon (11:00–12:00), afternoon (14:00–15:00), and evening (17:00–18:00). Within each time slot, panoramic photographs of the site were taken at a ten-minute interval, obtaining seven pictures per time slot. As no elevated vantage point was available, a tripod was used to capture multiple fixed-point shots, ensuring visual consistency and continuity across all observation periods.

For the GIS database establishment, all photographs were imported into ArcGIS for systematic data cleaning, classification, and coding. The image records were grouped according to gender, age, and activity type (i.e. guardian-accompanied playing and children’s free playing). To enhance the accuracy of age-classification, a machine-learning classifier based on WEKA (version 3.9.4) was employed, using visual cues from the photos (e.g., facial features, body posture, clothing style) to assist age recognition<sup>[29–30]</sup>. According to Jean Piaget’s theory of cognitive developmental stages<sup>[31]</sup>, participants were divided into two age groups: 0–7 years old and 8–18 years old. The younger group corresponds to early childhood, characterized by greater

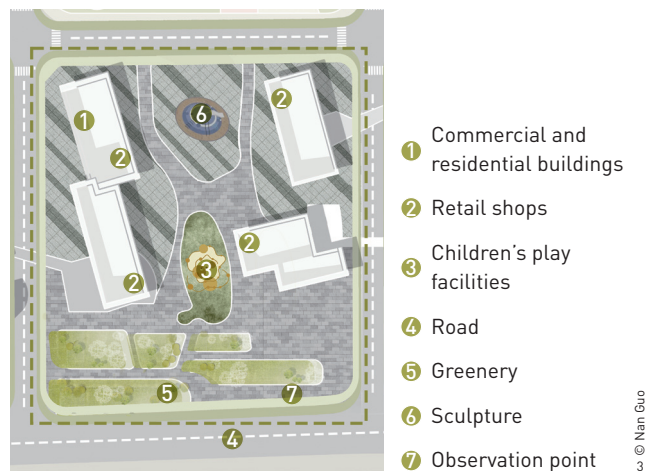
dependence on guardians; whereas the older group represents school-aged children with higher levels of independence, whose outdoor activity patterns are more strongly shaped by school schedules and institutionalized time structures.

Lastly, during the data analysis stage, quantitative statistical analysis was integrated with qualitative evidence (including STBM visualizations and questionnaire data) to systematically evaluate spatio-temporal behavioral differences between children and their guardians.

### 2.2.2 Scale Model Construction

To further investigate the influence of the built environment in shaping the everyday activities of children and their guardians, a questionnaire survey was conducted utilizing the Neighborhood Environment Walkability Scale (NEWS). The validity and reliability of this instrument have been widely recognized in previous studies<sup>[32]</sup>, and it has been extensively applied in urban design research as well as in practice<sup>[33–34]</sup>. The questionnaire survey was conducted offline, with primary caregivers (parents, grandparents, nannies, etc.) as respondents. The questionnaires were distributed primarily during afternoon and evening hours, with particular emphasis on the evening period, when outdoor activities involving children and their guardians were most frequent, thereby maximizing the the number of responses. The questionnaire comprised three main sections: 1) general information on the child and household, including the gender and age of children and guardians; 2) children’s behavioral characteristics within the community environment; 3) overall perception measurement of the community environment, encompassing five dimensions, namely transportation and travel, travel motivations, recreational activities, supporting facilities and services, and perceptions and preferences<sup>[34]</sup>. All questionnaire items were rated using a five-point Likert scale, where 1 represents the lowest level of evaluation (very poor) and 5 represents the highest level of evaluation (very good).

During the data processing phase, the Analytic Hierarchy Process (AHP) was employed to structure and synthesize the multiple items of NEWS into a hierarchical analytical framework<sup>[35]</sup>. To ensure the robustness of the weighting procedure, two urban design experts from Beijing Institute of Technology were invited to independently assess the relative importance of relevant factors. Subsequently, independent-samples *t*-tests were conducted to systematically examine the effects of gender differences on guardian’s behaviors, providing quantitative evidence of differences between male and female guardians in children’s everyday activities.



**Fig. 3** Study site.

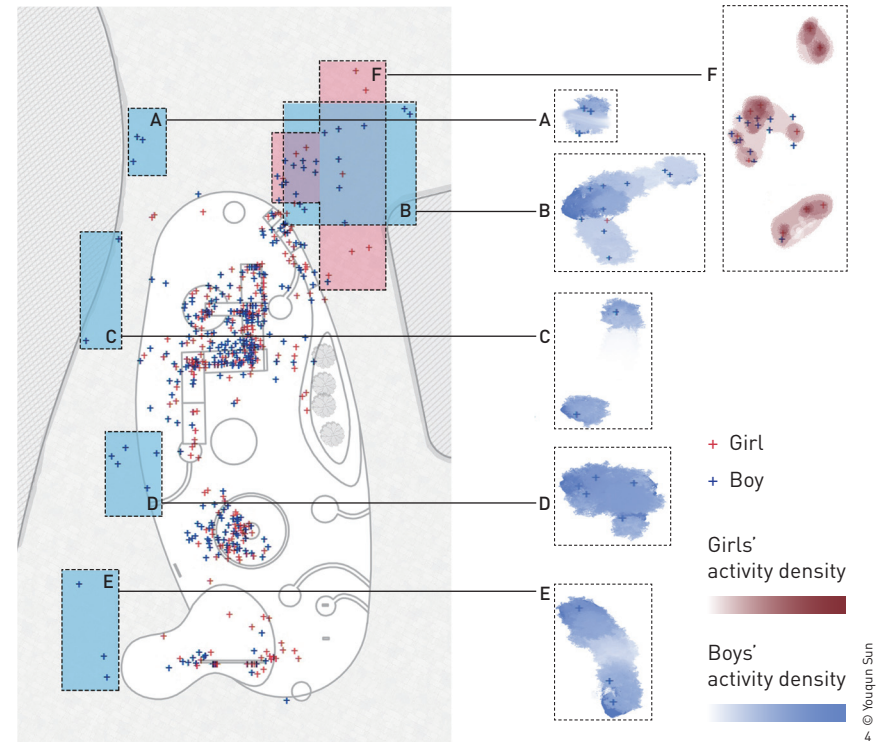
### 3 Results

#### 3.1 Differences in Outdoor Activity Participation by Children's Age and Gender

Table 1 illustrates the distribution of children's outdoor activity participation across different time periods. Overall, outdoor activities were more frequent among younger children compared with the older ones. The total of 915 younger children were observed, comprising 92% of the total sample; and gender distribution in this age group was nearly equal, comprising 448 boys and 467 girls. Further analysis revealed a significant gender difference among the older group. Specifically, the number of boys engaging in outdoor activities was 1.8 times higher than that of girls (47 boys and 26 girls), indicating that boys in this age group were more active in activity engagement within the community.

Besides, there are significant differences in the number of boys and girls participating in outdoor activities at different times of the day. The number of boys and girls who engaged in outdoor activities during the morning and midday times was relatively balanced. However, a pronounced difference emerged in the afternoon and evening, with the number of girls increasing noticeably in the afternoon, whereas the number of boys rose significantly in the evening.

To further reveal the spatial distribution characteristics of gender differences, the research employed STBM to visualize children's activity participation within the site (Fig. 4). The results indicated that the activity ranges of some boys extended beyond the boundaries of the central recreational facilities, and they were more frequently concentrated in peripheral areas, such as the plaza and shop entrances (Zones A to E), whereas some girls tended to congregate and play with more open and unobstructed spaces (Zone F). Notably, the proportion of boys in these peripheral areas was significantly higher than that of girls.



**Fig. 4** Spatial distribution of children's outdoor activity participation by gender across all time periods

#### 3.2 Spatio-Temporal Distribution of Caregivers' and Children's Outdoor Activities

The STBM results reveal distinct difference in spatial distribution of children's activities and their guardian's accompaniment at different time periods. In the morning, specifically, the number of children and their guardians was relatively small, and their spatial distribution was in a sparse dotted pattern, primarily concentrated along the southern and northern edges of the site (Fig. 5). At noon, spatial overlap between children and their guardians was relatively marked, primarily concentrated on the north and south of the site, which implies close interaction between children and their guardians during this time period. In the afternoon,

**Table 1: Distribution of children by age group and gender across different time periods**

Age	Boys					Girls				
	Morning	Noon	Afternoon	Evening	Total	Morning	Noon	Afternoon	Evening	Total
0-7	4	128	94	222	448	6	156	137	168	467
8-18	1	10	13	23	47	0	7	5	14	26
Total	5	138	107	245	495	6	163	142	182	493

although the spatial distribution of children’s activities did not change significantly, the spatial overlap between children and their guardians decreased sharply than that in noon. Similar to the noon period, more children engaging in independent play were recorded during the afternoon, indicating that guardians allowed children to engage more in independent activities during the daytime. By the evening, the spatial distributions of children and their guardians highly overlapped, with guardians’ distribution completely covering the children’s activity area, indicating that guardian supervision was most intensive during the evening period.

### 3.3 Gender Differences Among Guardians

Analysis of the data across all time periods shows that, although the number of male guardians increased significantly at noon and especially in the evening, female guardians still predominated the caregiving during children’s activity engagement (Table 2).

Furthermore, the number of female guardians is generally higher than that of male guardians, particularly pronounced at noon and in the evening, which also indicate that females usually undertake greater caregiving responsibilities in children’s everyday activities. Further comparison between weekday and weekend data shows that the numbers of both male and female guardians increased substantially on weekends. However, despite the rise in male guardian participation, their numbers remained lower than those of female guardians.

Moreover, to further explore the potential impact of gender differences among guardians on caregiving behaviors, this study used the AHP method to incorporate different factors that might affect guardian behaviors, and invited experts to conduct pairwise comparisons of each factor and assign weights accordingly (Table 3).

Besides, independent-samples *t*-tests were conducted to

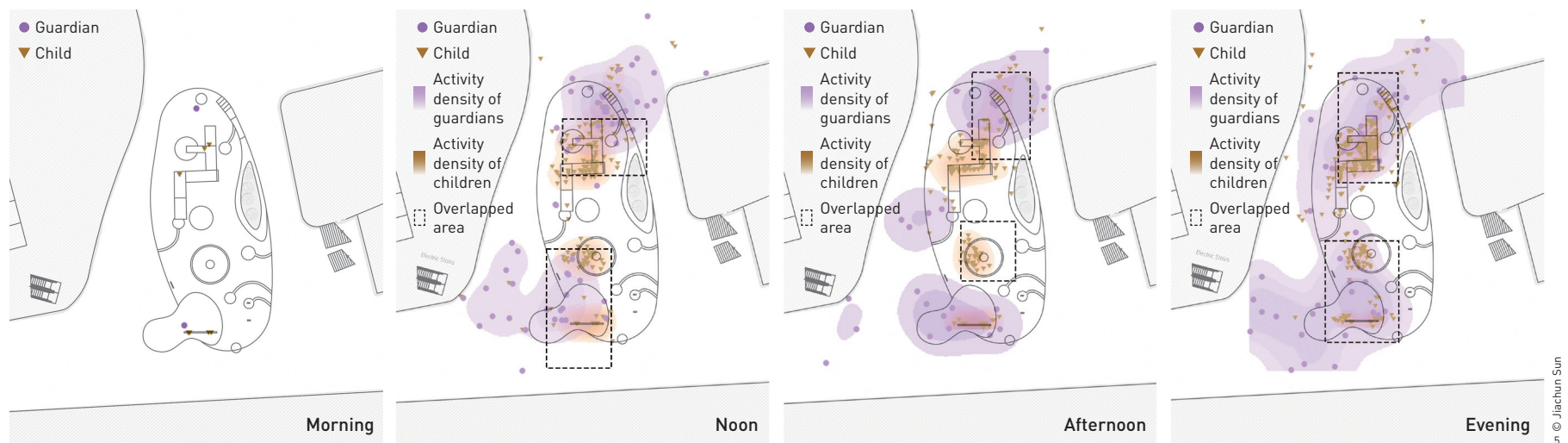


Fig. 5 Spatial distributions of children and guardians across time periods.

Table 2: Distribution of guardians by gender across different time periods on weekdays and weekends

Time period	Male				Female			
	Morning	Noon	Afternoon	Evening	Morning	Noon	Afternoon	Evening
Weekday	0	5	2	6	0	22	9	13
Weekend	1	9	6	8	1	20	12	10
Subtotal	1	14	8	14	1	42	21	23
Total		37				87		

**Table 3: Expert-assigned weights for dependent-variable sub-items**

<b>Dependent-variable classification</b>	<b>Dependent-variable sub-item</b>	<b>Weight</b>
<b>Dimension 1: Transportation and mobility</b>		
Street environment and safety	Sidewalks in the streets around my home are good, with barrier-free amenities (e.g. accessible curb ramps) and benches on the street	0.25
	Streets near my home are well equipped with pedestrian crossing aids (e.g., crosswalks, traffic signals)	0.21
	Sidewalks near my home are well maintained, with even surfaces and no damage	0.18
	Intersections near my home are closely spaced, and it is convenient to cross streets with children	0.14
	When walking with children near my home, sidewalks are generally unobstructed and sufficiently wide	0.11
	Street lighting near my home is good at night	0.07
	Street greenery near my home is good and provides shade for pedestrians	0.04
Travel and mobility	My daily commute to work is long, and I have little time to spend with my child after getting back home	0.50
	Vehicle speeds on streets near my home are mostly slow	0.33
	Streets near my home are not heavily trafficked	0.17
<b>Dimension 2: Travel motivations</b>		
Travel motivations	In my family, the responsibility for taking children out for activities is mainly borne by women	0.40
	I usually take my child with me when go groceries shopping for the family	0.30
	When taking a leisure walk outdoors within the community, I bring my child along	0.20
	When taking my child to/from school and passing through the community play space, I often stay to allow the child to play	0.10
<b>Dimension 3: Recreational activities</b>		
Recreational facilities	When children play around home, it is easy to find child-appropriate places to rest and seating for chatting	0.33
	When guardians supervise children around home, they can readily access appropriate resting spots and seating for conversation	0.27
	When (accompanying) children around the home, there is easy access to supportive facilities like handwashing sinks of children, nursing rooms, and toilets	0.20
	Play facilities near my home are well maintained, with no damage or safety hazards	0.13
	The ground surfacing in the places where children often play (e.g. rubberized surfaces, accessible ramps) is well provided and appropriate to run and jump on it	0.07
Accessibility and diversity of activity spaces	It is convenient to walk from home to locations appropriate for children's play and recreation	0.33
	There are many places near my home suitable for children's play and recreation (e.g., parks, sports grounds)	0.27
	When children play around home, they can easily find play equipment appropriate for their age	0.20
	There is a variety of play equipment and activity facilities near my home that can attract children to play	0.13
	The neighborhood offers good greenery/landscape, giving children opportunities to experience nature and observe plants and animals	0.07

(Continued)

**Table 3: Expert-assigned weights for dependent-variable sub-items** (Continued)

Dependent-variable classification	Dependent-variable sub-item	Weight
<b>Dimension 4: Supporting facilities and services</b>		
Public supporting facilities	From a childcare perspective, service facilities near my home are relatively well provided	0.29
	Overall, it is convenient to reach various daily services and facilities needed for children's everyday life from my home	0.24
	When taking a child along, it is easy to walk between home and child education and care facilities (e.g. primary schools, kindergartens)	0.19
	When accompanying a child, it is convenient to walk from home to child-related medical facilities (e.g., community hospitals/clinics)	0.14
	It is easy to walk from home to the stops of a public transport system when one has to accompany a child and take buses or metro	0.09
	When taking a child along, it is easy to walk from home to commercial facilities (e.g., stores, shopping centers) that can help children in their daily activities	0.05
<b>Dimension 5: Perceptions and preferences</b>		
Perceptions and preferences	Overall, the neighborhood is well suited to children's day-to-day living	0.20
	From a childcare perspective, I am generally satisfied with the surrounding environment and supporting facilities	0.18
	The overall neighborhood environment is child-friendly and supports a wide range of children's activities	0.16
	Traffic conditions near the residence are safe, with few traffic accidents	0.13
	I have a positive experience when accompanying my child in activities around home	0.11
	Children are frequently seen playing and engaging in outdoor activities around home	0.09
	Residents are frequently observed walking and engaging in outdoor leisure around home	0.07
	If necessary, I can turn to neighbors for help	0.04
	The neighborhood has a sound social cohesion, with neighbors I know and feel close to	0.02

examine the relationship between guardian's gender and each factor (Table 4). The results indicate that there are statistically significant effects on gender differences across various dimensions. Firstly, there was a significant gender difference in transportation and mobility ( $t = 3.177, p = 0.002$ ). Male guardians reported a higher mean score of 3.509 ( $SD = 0.741$ ) than females' 3.243 ( $SD = 0.618$ ). Combining the higher-weighted item, "My daily commute to work is long, and I have little time to spend with my child after getting back home," this finding suggests that male guardians are more prone to agree that longer commuting time reduces the time spent with children after work. This implies a more limited allocation of time between work and family responsibilities among male guardians,

which in turn influences their participation in children's everyday activities. Second, a significant gender difference was also observed in the dimension of travel motivations ( $t = -3.462, p = 0.001$ ). Specifically, female guardians reported a higher mean score of 3.920 ( $SD = 0.710$ ) than male guardians' score of 3.613 ( $SD = 0.665$ ), indicating that female were more involved in this dimension. Further examination of higher-weighted items, such as "In my family, the responsibility for taking children out for activities is mainly borne by women" and "I usually take my child with me when go groceries shopping for the family," revealed the gender difference in children's everyday travelling, accompaniment, and care-related activities in the family.

**Table 4: Comparison of factors influencing caregiving behavior between male and female guardians**

Dependent variable	Independent variable	N	Mean	SD	Sig.	t
Transportation and mobility	Male	90	3.509	0.741	0.002**	3.177
	Female	198	3.243	0.618		
Travel motivations	Male	90	3.613	0.665	0.001**	-3.462
	Female	198	3.920	0.710		
Recreational activities	Male	90	3.588	0.707	0.140	1.481
	Female	198	3.445	0.859		
Supporting facilities and services	Male	90	3.883	0.626	0.561	-0.582
	Female	198	3.932	0.675		
Perceptions and preferences	Male	90	3.944	0.557	0.513	0.655
	Female	198	3.896	0.597		

**NOTE**

\* indicates  $p < 0.05$ , and \*\* indicates  $p < 0.01$ .

Altogether, female guardians play a crucial and sustained role in accompanying children's everyday activities, and the division of household labor regarding children's outdoor activities and recreation is primarily taken by the female. This further evidenced that in most families, women are generally considered as the primary guardians for children, especially within the context of traditional culture.

## 4 Discussion: Guidance for Design Practice and Policy

### 4.1 Child-Guardian Interaction Patterns Under Children's Individual Differences

This study demonstrated that age differences among children lead to variations in their perceptions, needs, and behaviors within the community environment, which are consistent with previous research by scholars such as Amanda Bateman and Taina Laaksoharju<sup>[36-38]</sup>. Field observations reveal that children aged 0-7 years tend to be engaged in activities within semi-enclosed spaces with open view. Such spaces usually equipped with basic play amenities characterized by low complexity and low risk (e.g., slides, swings, rocking horses) and evenly-distributed, low-density

facilities, making it easy for guardians to provide prompt and close care. This also supports Piaget's theory that early childhood spatial cognition depends on specific physical boundaries<sup>[31]</sup>, which aligned with the characteristics of children at this stage whose cognitive and social abilities are not fully developed and whose perception of environment remains relatively simple<sup>[39-41]</sup>. In comparison, field observations suggest that children aged 8 to 18 years showed significantly greater activity demands, preferred games with rules and complexity, and larger spaces and more innovative recreational facilities. This indicates that children's needs for the physical environment are constantly changing at different stages of their growth, and as spatial exploration and autonomy increase, their dependence on close companionship from guardians will decrease<sup>[15]</sup>. These age differences also influence when and where guardians decide to take children out, which then shapes the way they engage and the decision-making patterns<sup>[23]</sup>.

Moreover, this study also revealed the different impact of physical environment facilities on children's participation patterns at different time periods. This finding contrasts with the view proposed by Inaki Larrea<sup>[42]</sup> and others, who suggest that affordance availability has a continuous and all-day promoting effect on children's activity participation. In this context, affordance availability refers to material characteristics of the environment that can be perceived by children and transformed into play behaviors, for instance, flat open surfaces that enable various activities such as ball games. The results of this study indicate that, across all observation periods, the number of children aged 0-7 years in outdoor activities was significantly higher than that of children aged 8-18 years, especially from noon to evening (Table 1). This is primarily attributed to that younger children are at the stage characterized by sensory development and environment exploration, and thus their everyday activities tend to be more inclined to play in open outdoor spaces. In contrast, children aged 8 to 18 years are greatly constrained by school schedules and institutionalized time structures, resulting in the comparatively low overall level of children's outdoor activities<sup>[31]</sup>. It is noteworthy that the number of outdoor activity children was significantly less in the morning than in the other three time periods. This can be explained by the fact that mornings often coincide with peak periods for guardians' work commuting and household labor, which result in limited opportunities for children to engage in outdoor activities. Taken together, these findings suggest that different time periods and age factors interact in the participation of children's and guardians' outdoor activities, mutually shaping temporal preferences, spatial use patterns, and levels of participation among different groups within the

community environment.

Analysis of children's activity distributions, together with field observations, indicates that boys tend to engage more frequently in exploratory and uncertain activities, demonstrating a stronger behavior inclination toward adventure and spatial exploration. For instance, boys are more likely to engage in loose spaces<sup>[20]</sup>, such as planted buffer zones, non-paved surfaces, and sloping areas. These spaces provided a wider range of activity and greater flexibility in interacting with the surroundings, while maintaining relatively manageable safety. In contrast, girls' activities are more concentrated in spaces with clearly defined boundaries, such as fence facilities and areas with explicit safety demarcations. This pattern is consistent with the findings of Roger Hart, as well as Gill Valentine and John McKendrick amongst others on children's spatial experiences<sup>[11,43]</sup>. Underlying these differences is the cultural construction of gender roles in spatial behavior<sup>[44]</sup>, namely, the societal expectation believed that "boys should be brave, exploratory, and willing to take risks," whereas "girls should be cautious and protected," which is reinforced through family education and neighbourhood interactions, thus potentially influencing children's understanding and everyday use of space<sup>[45-46]</sup>. This difference reveals how socio-cultural factors play a crucial role in shaping gender behavior patterns, working in conjunction with the characteristics of the physical environment to shape children's scope of participation, activity strategies, and spatial perception in community public spaces. This finding also underscores that the social construction of gender roles should be fully considered in community's spatial design to influence children's activity participation. For example, providing more open and flexible areas can support exploratory and adventurous activities often favored by boys, while offering engaging environment can promote girls' play experiences within a safe area. Through this, it could enhance the diversity and flexibility of the space, while addressing guardians' needs for visual supervision and safety control.

#### **4.2 Spatio-Temporal Characteristics and Bidirectional Effects of Child-Guardian Interaction Patterns**

This study has found that noon and evening are the peak hours for children's outdoor activities and for guardians taking them out for activity participation. The spatio-temporal characteristics is shaped by multiple interacting factors. First, the abundant sunshine and warm weather in March create comfortable conditions, which significantly enhance the willingness of guardians and children to participate in outdoor activities. Second, influenced by socio-

cultural factors, noon and evening periods regularly coincide with daily family activities such as grocery shopping and school-related travel. The accessibility and convenience of community amenities further influence the duration and frequency with which children and guardians occupy the community public space.

In addition, findings from on-site observations and questionnaire surveys showed that the caregiving behavior of guardians varied significantly at different time periods. At noon, guardians tended to maintain a moderate observation distance, creating a relatively free space for children to move around. This pattern was facilitated by the permeability and connectivity of the site, which ensured visual accessibility while preserving a degree of spatial enclosure, enabling guardians to effectively supervise children and encouraging them to independently engage with such spaces<sup>[47]</sup>. In the afternoon, guardians more frequently occupied resting facilities or peripheral areas within the site, and their behavior pattern shifted from moderate companionship<sup>[48]</sup> to low-intervention companionship<sup>[49]</sup>. This not only reflects the balance between the guardians' own needs for rest and the children's play needs in their everyday engagement, but also highlights the role of spatial configuration in guiding guardians' behavioral decisions. In the evening, as visibility decreased and the number of people increased, the lighting facilities in area became insufficient, which resulted in the more concentrated distribution of guardians' behaviors, with a significant increase in interaction with children. This change indicates that safety is the dominant factor influencing guardians' evening activity decisions, prompting a more proactive companionship in children's night-time activities<sup>[50]</sup> and intervention strategies aimed at mitigating potential risks.

The above findings not only demonstrate the interplay between spatial features, environmental factors, and behavioral patterns, but also suggest that child-guardian interactions are not characterized by one-sided dependence. Rather, they constitute an adaptive, intergenerational interaction pattern that emerges through everyday practices and mutual adjustment<sup>[17,51]</sup>. From a design perspective, the provision of spaces with a certain degree of enclosure can greatly enhance children's sense of safety and support the continuity of their activities, while simultaneously improving guardians' visual access and caregiving efficiency. Thus, two adjacent but independent areas can be connected through continuous green belts and landscape fence to form transitional edges<sup>[52]</sup>. These transitional spaces not only achieve a balance between visual accessibility and sense of security, but also encourage children's participation and their exploratory drives within the site.

### 4.3 Gender-Role Differentiation in Chinese Families: Women's Dominant Role in Caregiving

This study found that there are significant gender differences between male and female guardians in performing household labor. By contrast, female guardians generally undertake a greater share of caregiving duties, and even when experiencing the same commuting pressure as men, female tend to fulfill their caregiving duties to a greater extent. Thus, the current study believed that the relationship between gender differences in commuting time and family caregiving cannot be explained solely by individual choices, but more determined by the gender role expectations shaped by social culture. This difference reflects the long-standing stereotypes and institutionalized perceptions of the division of household labor between men and women<sup>[53]</sup>, whereby women are commonly perceived as the “inherent” providers of family care, while men are more associated with economic provision and social roles.

This gender difference in caregiving behavior presents new challenges for the design of community recreational spaces. First, given the primary role of female guardians in daily childcare, they spend more time in community spaces and engage in more diverse activities. Improving basic supporting facilities, such as seating, resting areas, and shaded spaces, can thus enhance their comfort during caregiving. Second, considering that male guardians' caregiving activities often occur in non-working hours, particularly in evenings and on weekends, the design of community recreational spaces should also take temporal patterns into account. For instance, existing research indicates that fathers are more likely to build close relationships with children through sports-related activities<sup>[54-55]</sup>. Therefore, increasing exercise areas or fitness facilities suitable for adults and children can promote parent-child interaction, thereby encouraging active participation by male guardians, and balancing the gender division of household labor.

## 5 Conclusions

This study takes a site in suburban Beijing as an example to explore the behavioral patterns of children and their guardians in outdoor activities within community loose spaces. The findings demonstrate that children's spatial needs change significantly with age. Specifically, children aged 0–7 years show a strong reliance upon guardians and preference for safe, semi-enclosed, small-scale spaces, whereas those aged 8–18 years exhibit greater independence and a need for more complex activity spaces. This not only influences children's activity engagement, but also shapes the way guardians accompany and guide them. Furthermore, children's

gender differences in outdoor activities are significant that boys tend to concentrate their activities in edge areas of community space, while girls more frequently engaged in play within defined spatial areas. Simultaneously, interactions between children and guardians show temporal differences, with noon and evening emerging as peak periods. These interactions dynamically change over time, reflecting the combined influence of family structure, daily routines, and socio-cultural factors.

Besides, in contrast to previous studies that primarily focused on children as independent subjects, the current study incorporates guardians into the empirical framework of child-environment interactions through the combining STBM with quantitative analysis. This study proposes a contextualized design strategy based on spatio-temporal behavioral characteristics, which strengthens the guiding significance of the research for urban design practices, while providing an empirical and scientific basis for policy-making in child-friendly community construction, especially in terms of spatial equity and guardian participation, thereby contributing to more inclusive and socially responsive urban environments.

However, this study also has certain limitations. First, the study is based on a single-community case, which constrains the representativeness and broader applicability of the findings. Second, both on-site observations and questionnaire surveys were conducted within a relatively short time periods, which is insufficient to reflect the seasonal or long-term dynamic characteristics of children's activity participation. Third, although the measurement scales incorporated gender and guardian role factors, they still fall short in considering other potential variables, such as socioeconomic status and educational background. Future research could address these limitations by adopting multi-case comparisons across different community types and urban contexts to enhance the applicability. Moreover, integrating top-down policymaking with bottom-up user feedback would help better understand how institutional frameworks and everyday practices interact in shaping child-friendly environments. Such an approach would contribute to promoting spatial equity and social inclusion, more effectively responding to the diverse needs of families and communities, and ultimately supporting the healthy development of children through more inclusive and participatory community loose space design.

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**Competing interests** | The authors declare that they have no competing interests.

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# 时空行为视角下社区松散空间对儿童与监护人行为特征的影响机制

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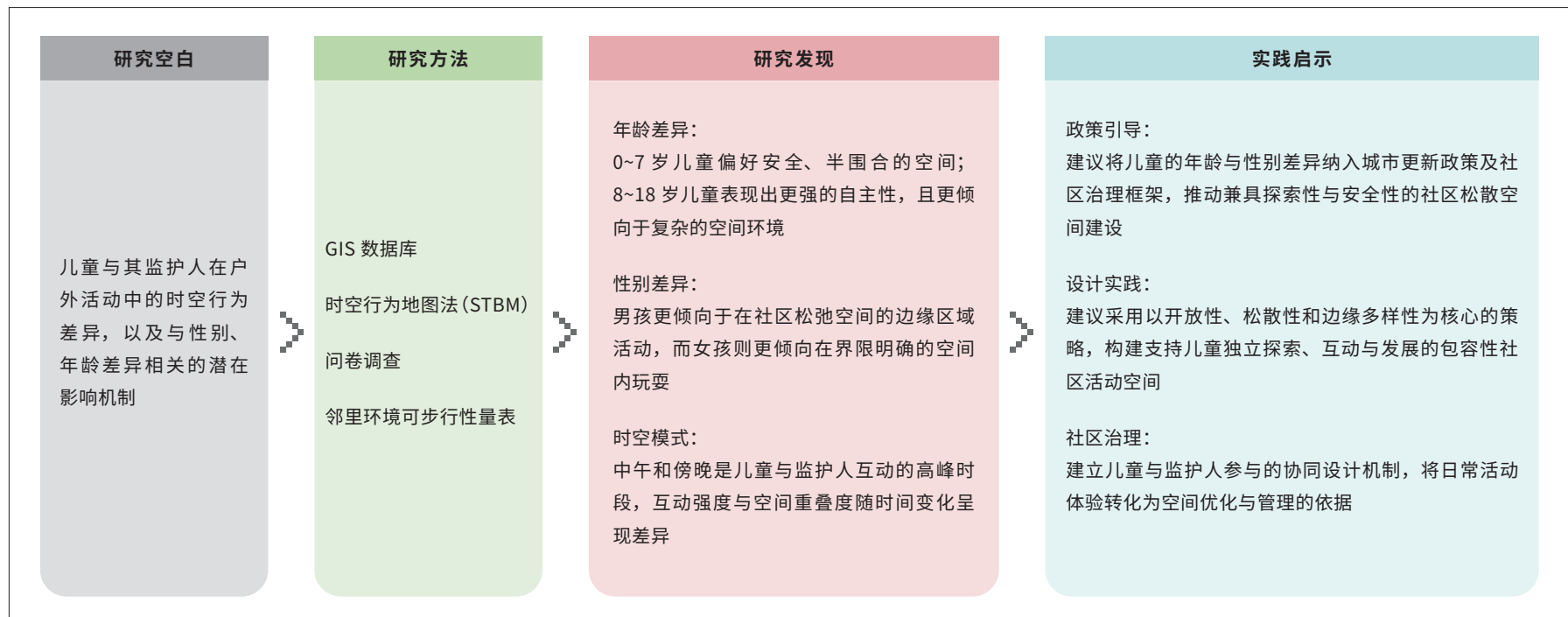
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## 图文摘要



## 摘要

社区公共空间作为儿童日常活动参与的重要载体, 其景观环境要素的优化对促进儿童健康具有积极影响。然而, 现有研究较少关注儿童及其监护人在户外活动中的时空行为差异, 及其不同性别与年龄的潜在作用机制。本研究以北京市房山区FCC中央城社区为研究场地, 通过将时空行为地图法 ( $N=988$ ) 和邻里环境可步行性量表 ( $N=302$ ) 相结合, 分析儿童及其监护人在性别、年龄、行为类型, 以及活动时段时空行为规律。研究结果表明: 1) 男孩活动人数与女孩相当, 但傍晚时段男孩活动人数显著高于女孩; 并且在该时间段男孩倾向于在场地边缘区域活

动, 而女孩则更多聚集于游乐设施周边区域。2) 男性监护人更多在周末或傍晚等时段参与儿童活动, 而女性监护人的参与则贯穿于儿童日常活动的各个时段。3) 性别差异与社会文化塑造的性别角色密切相关, 即监护人的性别差异决定其陪伴儿童的频率与时段, 也塑造了儿童的活动类型和空间偏好。此外, 本研究进一步揭示了交通出行和出行动机对儿童户外活动参与的影响。因此, 本文通过实证研究为儿童友好社区设计提供了理论与实践基础, 充分考虑了性别和年龄差异对于空间特征的需求, 以期提高儿童户外活动质量及监护人日常活动参与。

## 关键词

日常活动空间；儿童友好社区；时空行为地图；性别差异；环境行为特征；空间感知

## 文章亮点

- 男孩探索范围更倾向于“边缘-设施”的空间布局
- 揭示了儿童-监护人双向互动机制：儿童行为受监护人影响，同时反向塑造监护人的活动决策与空间选择
- 应将性别和年龄差异考虑其中，为儿童友好社区提出优化设计策略

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## 1 研究背景

儿童是城市未来的主人，也是社会可持续发展的基础。联合国儿童基金会于1996年提出的“儿童友好城市倡议”（Child Friendly Cities Initiative, CFCI）与之后的《儿童权利公约》都倡导在政策和设计层面保障儿童在城市生活中的参与权和健康权<sup>[1-2]</sup>。根据2020年联合国数据统计，中国约有2.98亿儿童，占总人口数的21.1%，约有1.87亿儿童生活在城镇地区，约占全国儿童总数的三分之二（62.9%）<sup>[3]</sup>。但是，在过去的30年间，中国儿童的活动空间随着城市化进程被逐渐压缩，学龄儿童户外活动明显减少，导致肥胖率持续上升<sup>[4-5]</sup>。

在此背景下，儿童友好城市倡议已在全球400余座城市进行了实践<sup>[6]</sup>。与此同时，儿童在城市中的行为特征、儿童对城市环境的感知，以及儿童行为与环境的关系正成为研究关注的重点<sup>[7]</sup>。有研究表明，儿童户外活动的多样性与复杂性受多重因素影响，其中年龄和性别差异、监护人参与模式及时间分布规律构成主要因素<sup>[8-13]</sup>。监护人在儿童户外活动中承担着至关重要的职责——他们不仅是儿童安全的照护人，也是其行为模式的塑造者<sup>[14]</sup>。亲子日常互动是当前儿童行为学和环境心理学研究中重要的研究方向<sup>[15]</sup>；随着社会老龄化的加剧，老年人作为照护人的比例也在逐渐上升<sup>[16-17]</sup>。除此之外，不同年龄段儿童每日户外活动时间及频率也受工作日与周末、季节与假期，以及监护人的时间安排等因素影响，呈现出较为稳定的规律性差异<sup>[14,18]</sup>。深入理解这些因素之间的相互作用，对

于优化儿童友好型社区空间环境设计、提升儿童户外活动质量具有重要意义。

相较于公园、广场，以及专门配置的儿童游乐设施等正式空间<sup>[19]</sup>，日常生活中的松散空间（loose space）<sup>[20]</sup>（如街巷、商铺周边、露天活动场地等）更能吸引儿童的参与和使用<sup>[21-23]</sup>。然而，当前学界对这些开放空间中的儿童行为模式、监护人行为特征及其社会空间关系仍缺乏深入探讨，尤其是年龄、性别和时间维度相互影响下的行为机制与互动参与研究更显匮乏<sup>[7,14,18,22-23]</sup>。基于此，本研究将聚焦社区松散空间内儿童及其监护人户外活动行为模式，探索不同时间段儿童和监护人的活动参与在空间分布上的差异。具体研究问题包括：

1) 儿童的年龄和性别在户外活动参与（如活动空间的选择）上是否存在差异？

2) 不同时间段内，儿童户外活动参与（如活动范围和空间聚集）是否受到监护人的影响？

3) 监护人性别差异对儿童照护时间以及空间使用偏好是否存在影响？

本研究通过探索儿童和监护人日常活动的时空行为特征，可为构建儿童友好型社区设计贡献新的实证视角，从而为促进儿童户外活动参与提供更具可操作性的空间设计策略。

## 2 研究内容

### 2.1 研究区域

本研究聚焦于北京市房山区FCC中央城社区。该社区因独特的地理位置与社会经济特征，成为特大城市近郊社区的典型代表：社区内聚集了大量跨区通勤人员，并呈现出“早晚高峰人流密集、日间人口稀疏”的独特时空模式<sup>[24]</sup>。基于此，本研究选取FCC中央城社区2号楼南侧户外空间为研究区域（图1），该区域面积约为772m<sup>2</sup>，并于2017—2019年间陆续建成。该场地设有丰富的娱乐设施，吸引儿童和监护人的参与，这为探讨社区松散空间中儿童及其监护人在户外活动中的行为模式提供了基础。

### 2.2 研究方法

#### 2.2.1 现场观察与时空行为地图法

本研究采用现场观察与时空行为地图法（Spatio-Temporal Behavior Mapping, STBM）<sup>[25-26]</sup>，以探索儿童与监护人的时空行为特征。具体而言，STBM聚焦于研究区域内活动者的性别、年龄、活动类型及时段（包括工作日与周末），并对其进行连续性观察与分析<sup>[27-28]</sup>。本研究方法共分为4个阶段（图2）：

1) 试点研究，用于验证观测工具与记录方式的可行性；

2) 数据收集，对儿童及监护人的行为开展系统化观测与记录；

3) GIS数据库建立, 将收集到的行为数据空间化并进行整合;

4) 数据分析, 利用ArcGIS平台开展时空分布特征及相关性分析。

首先, 在试点研究阶段, 对研究区域进行测量并绘制平面图, 分析场地周边环境特征, 界定研究场地范围并确定具体观测点位(图3)。

其次, 在数据收集阶段, 本研究于2023年3月9日、11日、15日、17日和19日开展了为期5天的系统性观察, 涵盖工作日(3天)与周末(2天), 其中观测时间段为每日的上午(8:00—9:00)、中午(11:00—12:00)、下午(14:00—15:00)和傍晚(17:00—18:00)。每个观测时段内, 研究人员以每10分钟拍摄1张全景照片的方式进行记录, 每小时共采集7张照片。由于研究场地缺乏高点拍摄条件, 故采用三脚架定点重复拍摄的方式, 以确保记录的连续性与可比性。

随后, 在GIS数据库建立阶段, 所有照片导入ArcGIS平台进行整理与编码。图像数据按照性别、年龄及活动类型(分为监护人陪同儿童玩耍和儿童自由玩耍2类)进行分类与整理。为提高年龄识别的准确性, 本研究则采用机器分类算法WEKA(version 3.9.4), 基于照片中人物的面部特征、动作神态、衣着风格等元素, 进行年龄识别<sup>[29-30]</sup>。依据让·皮亚杰认知发展阶段理论<sup>[31]</sup>, 将样本划分为0~7岁和8~18岁两个组别。前者处于早期探索阶段, 对监护人依赖度高; 而后者则进入自主性增强的学龄阶段, 其户外参与模式更易受到学校作息与社会制度化时间结构的影响。

最后, 在数据分析阶段, 本研究将采用定量(数据统计分析)和定性(时空行为地图、问卷调查)相结合的方式, 对儿童及监护人的时空行为差异特征进行系统分析。

### 2.2.2 量表模型构建

为进一步探讨环境空间对儿童及其监护人日常活动影响, 本研究主要采用包含“邻里环境可步行性量表”(Neighborhood Environment Walkability Scale, NEWS)的问卷调查方法。该量表的可靠性和有效性已得到学术界的认可<sup>[32]</sup>, 并已在城市设计中得到广泛使用<sup>[33-34]</sup>。问卷调查采用线下方式, 受访者为儿童的主要监护人, 包括父母、祖辈及日常看

护的保姆等。发放时间集中在下午和晚间; 其中, 晚间因社区内儿童及监护人户外活动较为集中, 成为问卷发放与回收的主要时段。问卷包括3个部分: 1) 儿童及其家庭基本信息, 包括监护人和儿童的性别与年龄; 2) 儿童在社区环境中的行为特征; 3) 社区环境的整体感知测量, 涵盖交通出行、出行动机、游憩活动、设施配套, 以及感知与偏好5个维度<sup>[34]</sup>。所有项目均采用5级李克特量表进行打分: 1分代表最负面的态度, 通常表示为“非常差”; 5分代表最积极的态度, 通常表示为“非常好”。

在数据处理方面, 本研究通过层次分析法(Analytic Hierarchy Process, AHP)对NEWS的测度项进行系统归纳<sup>[35]</sup>, 并邀请两位专家(北京理工大学城市设计学学者)对相关因素的相对重要性进行权重评分。随后采用独立样本t检验探究性别差异对监护人行为的影响, 从而为识别不同性别监护人在儿童日常活动中的差异提供定量依据。

## 3 研究结果

### 3.1 儿童的年龄与性别在户外活动参与的差异

表1展示了不同年龄段儿童在各时间段的分布差异。总体来看, 0~7岁儿童在户外活动中的参与人数高于8~18岁年龄段的儿童, 0~7岁儿童累计观测到915人(占总样本量的92%), 且男孩女孩比例基本持平(男孩448人, 女孩467人)。进一步分析发现, 在8~18岁群体中, 性别差异较为突出: 男孩的户外活动人数是女孩的1.8倍(男孩47人, 女孩26人), 表明该年龄段男孩在社区场地的活动参与更为活跃。

此外, 男孩和女孩在不同时间段的户外活动人数也存在较大差异。在上午和中午时段, 男孩和女孩人数较为均衡; 然而, 在下午和傍晚时段, 男孩与女孩的人数出现了较为明显的数量差异变化: 下午时段, 女孩人数有所增加; 而在傍晚时段, 男孩人数显著上升。

为了进一步揭示性别差异的空间分布特征, 本研究利用STBM对儿童在场地内的活动进行可视化分析(图4)。结果显示, 部分男孩的活动范围超出了中央娱乐设施的边界, 更倾向于在广场或商铺门口等场地边缘区域(区域A至E)活动, 而部分女孩则更倾向于在较为空旷的场地进行

表 1: 不同年龄段儿童在各时段的数量分布

年龄	男孩					女孩				
	上午	中午	下午	傍晚	总和	上午	中午	下午	傍晚	总和
0~7岁	4	128	94	222	448	6	156	137	168	467
8~18岁	1	10	13	23	47	0	7	5	14	26
总计	5	138	107	245	495	6	163	142	182	493

游玩（区域F）。值得注意的是，这些边缘区域中男孩人数比例明显高于女孩。

### 3.2 监护人与儿童户外活动的时空分布

STBM结果显示，儿童活动与监护人陪同行为的空间分布在不同时间段间呈现明显差异。具体来说，在上午时段，儿童和监护人的数量较少，呈点状稀疏分布，集中在场地的南北边界区域（图5）；在中午时段，儿童和监护人空间分布重叠程度相对较高，主要集中在场地的南北两侧，反映出二者在该时段的互动关系更为紧密。进入下午，尽管儿童活动的空间分布并未见明显变化，但儿童和监护人空间分布的重叠程度相较中午明显下降。与中午时段相似，该时段也出现更多儿童独立玩耍的行为活动，表明白天时段监护人给予儿童更多的自主活动空间。至傍晚时段，儿童和监护人的空间分布高度重叠，其中监护人的分布范围完全覆盖了儿童的活动区域。这一现象表明傍晚是监护人对子女照看最为集中的时段。

### 3.3 监护人的性别差异

全时段数据的分析结果显示（表2），尽管在中午和傍晚时段男性监护人人数明显增多（尤其是傍晚），但女性监护人在儿童活动的陪伴与照护中占主导地位，且在所有时段中女性监护人数普遍高于男性（尤其是中午和傍晚时段），这表明女性在日常生活中往往承担更多的照护职责。进一步比较工作日和周末时段的数据，发现男性和女性监护人的数量在周末均明显增加；男性监护人的数量虽在周末有所上升，但仍低于女性。

此外，为进一步探讨监护人性别差异对照护行为的潜在影响，本研究引入AHP对可能影响监护人行为的因子进行归纳，并邀请专家以成对各因子的权重进行评估（表3）。

此外，本研究对不同性别监护人与各因子的关系进行独立样本t检验分析（表4）。结果显示，性别差异在多个维度上均有显著性影响。首

表 2：不同性别监护人在工作日/周末不同时段和的数量分布

时段	男性				女性			
	上午	中午	下午	傍晚	上午	中午	下午	傍晚
工作日	0	5	2	6	0	22	9	13
周末	1	9	6	8	1	20	12	10
小计	1	14	8	14	1	42	21	23
总计	37				87			

表 3：因变量子项目权重表

因变量归类	因变量子项目	权重
<b>测度项 1：交通出行</b>		
街道环境与安全性	家附近街道的人行道设施较完善，有无障碍设施（如无障碍缓坡）、街道座椅等	0.25
	家附近街道的辅助过街设施（如人行横道、红绿灯）配置较完善	0.21
	家附近人行道的维护状况较好，地面平坦、无破损	0.18
	家附近交叉路口的间隔较近，可方便地带孩子过马路	0.14
	带儿童在家附近街道步行时，人行道一般没什么障碍物，宽度充足	0.11
	家附近街道的夜间照明良好	0.07
	家附近街道的绿化情况较好，可以为行人提供绿荫遮阳	0.04
交通出行	每天上班交通通勤时间较长，回家后陪孩子时间较短	0.50
	在家附近街道，车辆行驶速度大多较慢	0.33
	家附近街道的交通不太繁忙	0.17
<b>测度项 2：出行动机</b>		
出行动机	在家庭中，带领儿童外出活动的责任主要由女性承担	0.40
	为家庭采购食材时，会携带儿童一同前往	0.30
	在小区内进行户外休闲散步时，会携带儿童一同前往	0.20
	在接送儿童上下学的过程中和经过小区儿童娱乐场地时，会停留以让儿童进行娱乐活动	0.10
<b>测度项 3：游憩活动</b>		
游憩设施	儿童在家附近活动时，可方便地找到适宜儿童的休息场所、聊天座椅设施	0.33
	监护人照护儿童在家附近活动时，监护人可方便地找到适宜儿童的休息场所、聊天座椅设施	0.27
	（带）儿童在家附近活动时，可方便地找到儿童洗手池、母婴室、卫生间等辅助设施	0.20

（续表见下页）

表 3：因变量量子项目权重表 (接上表)

因变量归类	因变量量子项目	权重
<b>测度项 3：游憩活动</b>		
游憩设施	家附近的游乐设施维护状况较好，没有损坏或安全隐患	0.13
	儿童常去活动地点地面铺装（塑胶地面、无障碍缓坡等）配置很好，适宜儿童跑跳	0.07
活动场地 可达性 及丰富度	从家出发，可以方便地步行到达适宜儿童游戏、休闲活动的地点	0.33
	家附近有很多适合儿童游戏、休闲活动的地方（如公园、运动场地）	0.27
	儿童在家附近活动时，可方便地找到适宜儿童年龄段的游戏器械	0.20
	家附近的游乐器械、活动设施类型多样，会吸引孩子玩耍	0.13
	家附近有有良好的绿化景观，孩子有机会接触自然环境、观察动植物	0.07
<b>测度项 4：设施配套</b>		
公共配套设施	从照顾儿童角度来看，家附近的服务设施配置比较完善	0.29
	总体上看，从我家出发，可以方便地到达儿童生活所需的各类生活配套设施	0.24
	（带）儿童从家出发，可以方便地步行抵达儿童教育照护设施（如小学、幼儿园）	0.19
	（带）儿童从家出发，可以方便地步行抵达儿童医疗相关设施（如社区医院）	0.14
	（带）儿童从家出发，可以方便地步行去公共交通站点乘坐公交或地铁	0.09
	（带）儿童从家出发，可以方便地步行抵达儿童生活所需的商业设施（如商店、商场）	0.05
<b>测度项 5：感知与偏好</b>		
感知与偏好	总的来看，居住地比较适宜儿童居住生活	0.20
	从照顾儿童生活角度来看，对于居住地及周边的环境与设施配套较满意	0.18

表 3：因变量量子项目权重表 (接上表)

因变量归类	因变量量子项目	权重
<b>测度项 5：感知与偏好</b>		
感知与偏好	居住地及周边的总体环境对儿童很友好，适宜儿童进行各类活动	0.16
	居住地附近的交通安全情况很好，没怎么发生过交通事故	0.13
	带儿童在家附近活动时，体验很好	0.11
	居住地附近，经常能看到儿童在户外玩耍、活动	0.09
	居住地附近，经常能看到居民们在户外散步、休闲活动	0.07
	如有需要时，可向邻居寻求帮助	0.04
	居住地邻里氛围比较好，有熟识、亲近的邻居	0.02

表 4：不同性别监护人在照护行为影响因素上的对比

因变量	自变量	样本数量	平均值	SD	Sig.	t
交通出行	男	90	3.509	0.741	0.002**	3.177
	女	198	3.243	0.618		
出行动机	男	90	3.613	0.665	0.001**	-3.462
	女	198	3.920	0.710		
游憩活动	男	90	3.588	0.707	0.140	1.481
	女	198	3.445	0.859		
设施配套	男	90	3.883	0.626	0.561	-0.582
	女	198	3.932	0.675		
感知与偏好	男	90	3.944	0.557	0.513	0.655
	女	198	3.896	0.597		

注

\*表示 $p < 0.05$ ，\*\* $p$ 表示 $< 0.01$ 。

先，在交通出行维度，男性与女性呈显著性差异（ $t=3.177$ ， $p=0.002$ ）。男性的平均得分为3.509（ $SD=0.741$ ）高于女性监护人的3.243（ $SD=0.618$ ）。结合权重较高项（“我每天上班交通通勤时间较长，回

家后陪伴孩子的时间较短” ) 可以发现, 男性监护人相较于女性监护人更倾向于认同通勤时间较长会压缩回家后陪伴孩子的时间。这表明, 男性在工作 and 家庭责任之间的时间分配受到较大限制, 从而影响其在儿童日常活动的参与程度。其次, 在出行动机维度, 监护人性别差异也同样显著 ( $t=-3.462, p=0.001$ ): 男性平均得分为3.613 ( $SD=0.665$ ), 而女性为3.920 ( $SD=0.710$ ), 表明女性在该维度上的参与程度更高。进一步结合权重较高项发现, “在家庭中, 带领儿童外出活动的责任主要由女性承担”, 以及“为家庭采购食材时, 会携带儿童一同前往”等得分较高, 反映出儿童日常出行、陪伴与照护活动在家庭内部呈现出明显的性别分化特征。

整体而言, 女性监护人在儿童日常活动陪伴中承担着更为核心和持续的角色, 家庭内部关于儿童外出活动与娱乐的责任分工仍以女性为主。这进一步印证了在多数家庭中, 尤其是在传统文化背景下, 女性通常被视为儿童的主要照护者。

## 4 讨论: 对设计实践和政策的指导意义

### 4.1 儿童个体差异影响下的儿童—监护人互动模式

本研究发现儿童的年龄差异引发了儿童对社区环境的感知、需求以及行为发生变化, 这与阿曼达·贝特曼、泰娜·拉克索哈尤等学者的研究结果相符<sup>[36-38]</sup>。现场观察发现, 0~7岁的儿童更倾向于在视线通透的半围合空间内活动, 这类空间通常配备低复杂度、低风险的基础游乐设施(如滑滑梯、秋千、摇摇马等), 并且设施分布均衡、密度较低, 便于监护人近距离照护。这也印证了皮亚杰关于儿童早期空间认知依赖具体物理边界的理论<sup>[31]</sup>, 与儿童在此阶段的认知与社交能力尚未完全发展、环境理解较为简单的特征相契合<sup>[39-41]</sup>。相比之下, 现场观察发现8~18岁儿童对活动量的需求明显提升, 更偏好具有规则性和复杂性的游戏, 以及较大场地和更具创新性的娱乐设施。这表明儿童在不同成长阶段对于物质环境的需求也在不断发生变化, 且随着其空间探索与自主性逐渐增强, 对监护人密集陪伴的依赖也会减少<sup>[15]</sup>。这种年龄差异也影响了监护人对外出时间与场所的选择, 进而影响了其参与方式与决策模式<sup>[23]</sup>。

此外, 本研究也揭示了物质环境设施在不同时间段对儿童参与模式的差异性影响。与伊纳基·拉雷亚<sup>[42]</sup>等学者提出的“设施可供性对儿童活动参与具有持续性、全天候促进作用”的观点不同, 其中可供性指环境中可被儿童感知并转化为游戏行为的物质特性, 如平坦的地面有助于开展踢球等运动。本研究结果显示, 在所有观测时段中, 0~7岁儿童的户外活动人数显著高于8~18岁儿童, 且中午至傍晚时段尤为明显(表1)。这主要源于0~7岁儿童处于感知发展和环境探索阶段, 其日常活动更倾向于在户外开敞空间玩耍; 而8~18岁儿童受学校作息制约, 整

体活动人数则相对较低<sup>[31]</sup>。值得注意的是, 上午时段的儿童活动人数显著低于其他3个时段。其主要原因在于上午时段通常为监护人通勤出行或处理家庭事务的高峰期, 导致此时儿童外出活动机会相对受限。这一结果表明, 时段与年龄因素在监护人与儿童户外活动参与时相互影响, 共同塑造了不同群体的时间和空间使用偏好与参与模式。

通过儿童活动分布分析和现场观察发现, 男孩更倾向于具有探索性和不确定性的活动, 表现出更强的冒险意识与空间探索行为。例如, 男孩更常在“松散空间”<sup>[20]</sup>(如植被缓冲带、非硬质铺装地面、具有坡度的区域)中进行游戏活动。此类空间提供了更大的活动范围、更强的与环境可塑性, 同时仍保持相对可控的安全性。相较之下, 女孩的活动则更多集中于具有“明确边界”的空间, 例如带护栏的设施或功能明确的安全区。这一差异与罗杰·哈特, 以及吉尔·瓦伦丁和约翰·麦肯德里克等学者关于儿童空间经验的研究结论相一致<sup>[11,43]</sup>。其背后反映了社会性别角色在空间行为中的文化建构<sup>[44]</sup>, 即社会对于“男孩应该勇于探索与挑战”和“女孩应该保持小心与被保护”的文化期待, 通过家庭教育和邻里互动不断强化, 从而潜在影响儿童对空间的理解和参与方式<sup>[45-46]</sup>。这一差异揭示了社会文化对于性别行为模式的塑造, 与物质环境特征共同作用, 塑造了儿童在公共空间中的参与范围、活动策略和空间感知。这一发现也说明, 在社区空间设计中应充分考虑性别角色的社会建构对活动参与的影响。例如, 男孩可以有更多的开放区域以支持冒险性活动, 女孩则可以在一定安全的范围内有更多的游玩体验, 从而提升空间的多样性和灵活性, 同时满足监护人的视线管理需求。

### 4.2 儿童与监护人互动模式的时空特征与双向影响

研究发现, 中午和傍晚是儿童玩耍及监护人带领儿童进行户外活动的高频时段。时空特征的形成受到多重因素的影响。首先, 3月气温回升、阳光充足, 舒适的天气条件会显著提高监护人和儿童的户外活动参与意愿。其次, 受社会文化因素影响, 中午和傍晚通常与家庭采购、接送儿童上下学等高频出行需求相重合。社区空间内生活配套设施的可达性也会影响儿童与监护人在公共空间的停留时间。

此外, 现场观察和问卷调查结果表明, 监护人在不同时间段的照护行为呈现出明显差异。在中午时段, 监护人更倾向于保持适度的观察距离, 为儿童营造相对自由的活動空间。这一模式得益于场地的渗透性和相连性设计, 在保持空间围合感的同时确保视线的可达性, 使监护人能在鼓励儿童独立活动的情况下实现有效监护<sup>[47]</sup>。在下午时段, 监护人更多选择场地中的休息设施或边缘区域, 行为模式呈现出从适度陪伴<sup>[48]</sup>向低介入陪伴<sup>[49]</sup>的转变。这不仅体现了监护人在日常活动中对自身体息需求与儿童娱乐需求的平衡, 也表明场地空间形态对行为决策的引导作用。而在傍晚时段, 随着天色渐暗和场地人流量的增加, 场地照明设施不足, 监护人的行为分布再度集中, 且与儿童之间的互动显著增强。这

一变化表明，安全性是监护人晚间活动决策的核心影响因素<sup>[50]</sup>，促使其采取更加积极的陪伴与干预策略，以降低潜在风险。

以上研究发现不仅凸显了空间特征、环境条件与行为模式之间的互动机制，也印证了监护人与儿童的互动并非单向依赖，而是通过日常实践形成一种具有适应性的代际互动模式<sup>[17,51]</sup>。在设计实践中，设置具有一定程度的围合空间更能促进儿童的活动安全感和持续性，同时提升监护人的可视范围和照护效率。因此，可通过连续绿化带、景观围栏来衔接两个相邻的独立区域，从而形成过渡性空间<sup>[52]</sup>。这不仅可以实现视觉可达性和安全感之间的平衡，还可以鼓励儿童在区域范围内的活动参与和探索欲。

### 4.3 中国社会背景下家庭的性别角色差异：女性在家庭监护中的主导地位

本研究发现，男性和女性监护人在承担家庭责任时存在性别差异。相比之下，女性监护人通常承担更多的家庭责任，即使面临与男性一样的通勤压力，女性往往也会更大程度上来继续履行照护职责。因此，本文认为，性别差异在通勤时间与家庭照护职责之间的关系，不仅缘于个体选择，更多是由社会文化所塑造的性别角色期望所决定的。这一差异体现了社会长期以来对男女家庭分工的刻板印象和制度化认知<sup>[53]</sup>：女性普遍被认为是家庭照护的“自然”承担者，而男性则更多与经济供养和社会角色联系在一起。

这种性别差异对监护行为的影响，对社区休憩空间设计提出了新的要求。首先，鉴于女性监护人在日常照护中的主要角色，其在社区空间中停留的时间更长且活动类型更为多元，因此休息区、座椅等基本生活设施的完善将有助于提升其照护行为的舒适度。其次，针对男性监护人对儿童的照护行为多发生在非工作时段（如傍晚和周末），社区休憩空间的设计也应考虑到这一时间分配差异。例如，已有研究指出父亲角色通过体育运动更易与儿童建立亲密关系<sup>[54-55]</sup>，因此可增加运动区或适合成人与儿童共同使用的体能设施，以促进亲子互动，从而促进男性监护人积极参与，平衡家庭内部的性别分工。

## 5 结论

本研究以中国特大城市近郊社区为例，探讨社区松散空间中儿童及其监护人在户外活动中的行为模式。研究结果证明，儿童的空间需求随年龄增长而发生显著变化：0~7岁的儿童依赖监护人，偏好安全、半围合的小尺度空间；而8~18岁的儿童则展现出更强的独立性和对复杂活动空间的需求。这不仅影响儿童活动参与，也塑造了监护人的陪伴与引导方式。此外，户外活动中的性别差异也不可忽视：男孩在边缘空间的活动更为集中，而女孩则更倾向于在明确的空间范围内玩耍。与此同时，儿

童与监护人的互动呈现出时间差异，中午和傍晚为主要高峰期，互动关系随时间动态变化，反映出家庭结构、作息习惯与社会文化的综合影响。

此外，不同于以往研究中对儿童单一主体的关注，本研究通过将STBM与定量分析相结合，将监护人纳入儿童与环境互动的实证框架，提出了基于时空行为特征的情境化设计策略，强化了研究对城市空间设计实践的指导意义，为儿童友好型社区空间的政策制定提供了科学依据，尤其是在空间公平和监护人参与方面，推动了城市包容性发展。

然而，本研究亦存在一定局限性。首先，研究基于单一社区案例，样本的代表性有限。其次，现场观察与调查问卷数据均集中于短期时段，尚不足以反映儿童活动的季节性或长期动态特征。再次，量表测度虽引入了性别与监护人角色因素，但对社会经济背景、教育水平等潜在变量的考量仍有不足。未来研究可通过多案例对比的方式增强研究结论的普适性，并应关注“自上而下”的政策制定与“自下而上”的使用者反馈双重路径，推动空间公平与社会包容性的发展，从而更有效地回应家庭与社区的多元需求，为儿童创造更具包容性与参与性的社区空间，以促进其健康成长。

图 1. 研究场地实景照片

图 2. STBM 研究方法流程图

图 3. 研究场地环境示意

图 4. 不同性别儿童在全时段的户外活动参与分布图

图 5. 不同时间段监护人与儿童空间分布